PRINT DATE: 08/09/00

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 05-2R-5300 -X

SUBSYSTEM NAME: COMMUNICATION & TRACKING
REVISION: 0 06/27/88

PART DATA

	PART NAME	**PART NUMBER**
	VENDOR NAME	**VENDOR NUMBER**
	: MIDBODY	
LRU	: KU-BAND DA-A	MC409-0025-300X

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FOR 05-2R-5300-1, 05-2R-5300-2, 05-2R-5300-3, 05-2R-5300-4, AND 05-2R-5300-5:
DA-A, KU-BAND, DEPLOYED ASSEMBLY A

FOR 05-2R-5300-6:
DA-A, KU-BAND DEPLOYED ASSEMBLY A (THERMOSTATS)

FOR 05-2R-5300-7:
DA-A, KU-BAND DEPLOYED ASSEMBLY A (TEMPERATURE SENSOR)

REFERENCE DESIGNATORS: 40V74A33

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
FOR 05-2R-5300-1, 05-2R-5300-2, 05-2R-5300-3, 05-2R-5300-4, AND 05-2R-5300-5:
DOWN-CONVERTS TO "IF" SIGNAL, A RECEIVED TDRSS FORWARD LINK SIGNAL OR RETURNED SIGNAL FROM A RADAR TARGET AND PROVIDES FINAL FREQUENCY UP-CONVERSION AND RF AMPLIFICATION FOR ALL COMM & RADAR TRANSMISSIONS. PERFORMS RF SWITCHING FUNCTIONS RESPONDS TO ANTENNA DRIVE SIGNALS, PROVIDES OUTPUT DEFINING ANTENNA POSITION AND ANGULAR RATES OF CHANGE, AND SUPPORTS RADAR SELF-TEST. PROVIDES INDICATION THAT GIMBALS ARE LOCKED (BOOM STOW II).

FOR 05-2R-5300-6:
PROVIDE TEMPERATURE CONTROL OF THE FOLLOWING: GYRO, ANTENNA FEED, BETA AXIS GIMBAL, ALPHA AXIS GIMBAL, TRANSMITTER HEATER, AND RECEIVER HEATER.

FOR 05-2R-5300-7:

FAILURE MODES EFFECTS ANALYSIS (FMEA) --CIL HARDWARE
NUMBER: 05-2R-5300-X

PROVIDES TEMPERATURE MONITORING CAPABILITY (NOT PART OF HEATER CONTROL CIRCUITS) FOR THE FOLLOWING: TRANSMITTER HEATER, RECEIVER HEATER, BETA AXIS GIMBAL, ALPHA AXIS GIMBAL, GYRO, AND ANTENNA FEED. DA/40V74A33, TEMPERATURE SENSORS (INTERNAL): V74T2497A, V74T2961A, V74T2969A, V74T2965A, V74T2967A, V74T2963A.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE
NUMBER: 05-2R-5300- 03

REVISION#: 2 06/22/00

SUBSYSTEM NAME: COMMUNICATION & TRACKING
LRU: KU-BAND, DA-A
ITEM NAME: KU-BAND, DA-A

CRITICALITY OF THIS FAILURE MODE: 1/1

FAILURE MODE:
LOSS OF TRANSMIT INHIBIT, FAIL TO INHIBIT TRANSMITTER WHILE ANTENNA IS IN OBSCURATION ZONE.

MISSION PHASE: OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
VIBRATION, TEMPERATURE, MECHANICAL SHOCK, CONTAMINATION, MISHANDLING, PIECE-PART STRUCTURAL FAILURE, ENCODER FAILURE.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
SINGLE FAILURE OF A COMPONENT IN THE TRANSMITTER INHIBIT CIRCUIT WILL ALLOW TRANSMITTER TO CONTINUE TO RADIATE WHEN ANTENNA IS POINTED INTO OBSCURATION ZONE.

(B) INTERFACING SUBSYSTEM(S):

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 05-2R-5300- 03

RF RADIATION CONTAMINATION CAUSING INADVERTENT APDS PYROS FIRING (CRITICALITY 1/1).

RF RADIATION CONTAMINATION IN PAYLOAD BAY RESULTING IN POSSIBLE DAMAGE TO A PRIME MISSION OBJECTIVE PAYLOAD (CRITICALITY 2/2).

(C) MISSION:
RADIATION OF APDS RESULTING IN ODS PYRO FIRING PRIOR TO DOCKING WOULD RESULT IN LOSS OF MISSION DUE TO INABILITY TO DOCK.(CRITICALITY 2/2).

RADIATION THAT DAMAGE PRIME MISSION OBJECTIVE PAYLOAD WOULD RESULT IN INABILITY TO ACCOMPLISH A PRIME MISSION OBJECTIVE (CRITICALITY 2/2).

(D) CREW, VEHICLE, AND ELEMENT(S):
RADIATION OF ANDROGYNOUS PERIPHERAL DOCKING SYSTEM (APDS) RESULTING IN INADVERTENT FIRING OF THREE OR MORE ADJACENT ODS PYROS WHILE ORBITER IS DOCKED TO ISS AND THE DOCKING HATCHES ARE OPEN COULD RESULT IN LOSS OF CREW/VEHICLE DUE TO VEHICLE SEPARATION AND/OR LOSS OF PRESSURE IN THE HABITABLE ENVIRONMENT. HARD STOP WILL NOT ALLOW KU-BAND ANTENNA TO RADIATE MORE THAN THREE ADJACENT PYROS (OF 12 APDS PYROS) WITHIN THE ANTENNA NEAR FIELD CYLINDRICAL BEAM. WORST CASE SCENARIO: THE THREE ADJACENT PYROS WILL BE ON PERIPHERY OF ANTENNA MAIN BEAM. ALTHOUGH, RADIATION LEVELS AT CENTER OF MAIN BEAM CAN REACH 300 V/M RMS, THE MAXIMUM RADIATION LEVELS SEEN BY THE PYROS ON THE PERIPHERY OF THE MAIN BEAM WILL BE BETWEEN 65 AND 100 V/M RMS. THERE ARE TWO ADDITIONAL PYROS, WHICH COULD SEE KU RADIATION BETWEEN 20 AND 40 V/M RMS (OUTSIDE OF THE ANTENNA NEAR FIELD CYLINDRICAL BEAM). PYROS ARE CERTIFIED AT 20 V/M RMS (TESTED AT 200 V/M RMS). APDS IS CERTIFIED FOR LOSS OF TWO ADJACENT LATCHES.

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: IMMEDIATE

-DISPOSITION RATIONALE-

(A) DESIGN:
THE PROBABILITY OF THE FAILURE MODE WHICH COULD RESULT IN LOSS OF THE TRANSMITTER INHIBIT IS LOW – MEAN TIME BETWEEN FAILURE (MTBF) IS 817,000 HOURS, OR OVER 93 YEARS.
ALL EEE PARTS ARE SELECTED FROM OR IN ACCORDANCE WITH MF0004-400 (OPPL) REQUIREMENTS. SUBASSEMBLIES ARE QUALIFIED BY TEST OR USE OF EXISTING DESIGNS QUALIFIED FOR OTHER NASA & MILITARY PROGRAMS. THE DEA IS SEALED AND PRESSURIZED WITH NITROGEN/HELIUM GAS TO PROTECT CIRCUITS AND COMPONENTS FROM DIRECT EXPOSURE TO THE ENVIRONMENT. THE SYSTEM DESIGN INCLUDES A DEPLOYED ASSEMBLY JETTISON CAPABILITY WHICH CAN BE USED IF THE SYSTEM FAILS TO RESPOND TO LOCK OR STOW COMMANDS.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 05-2R-5300- 03

ACCEPTABILITY OF THE DA CERTIFICATION DEVIATIONS REGARDING NON- EXPLOSION PROOF GIMBAL MOTORS AND NON-STANDARD TERMINATIONS IS BASED ON THE FOLLOWING:

THE GIMBAL MOTORS ON THE DEPLOYED ASSEMBLY ARE NOT EXPLOSION PROOF. THESE MOTORS ARE DEACTIVATED WHEN THE GIMBAL IS LOCKED, EVEN WHEN THE KU-BAND EQUIPMENT IS "ON". DURING ON-ORBIT OPERATIONS, THE GIMBAL REMAINS LOCKED, AND THE MOTOR DRIVE INHIBITED UNTIL PAYLOAD DOORS HAVE BEEN FULLY OPENED AND THE DEPLOYED ASSEMBLY DEPLOYED TO ITS OPERATING POSITION, PLACING THE GIMBAL (AND MOTORS) OUTSIDE, AND FORWARD OF, THE PAYLOAD BAY. THE MOTORS, THEREFORE, REPRESENT NO POTENTIAL IGNITION SOURCE, FOR A COMBUSTIBLE ATMOSPHERE, EXCEPT DURING GROUND OPERATIONS WHERE A PRECAUTIONARY NOTE HAS BEEN ADDED TO KSC ORBITER GROUND TEST OMRSD AND KSC SHUTTLE GROUND TEST OMRSD.

THE "WHITE WIRE" FIX FOR THE "200 VOLT" CATHODE REGULATOR CIRCUIT LOCATED IN THE A9A1 PWB IS A "CUT AND JUMPER" FIX INVOLVING 15 CUTS OF COMPONENT LEADS AND ADDING 14 JUMPER WIRES UTILIZING PROCEDURES AND TECHNIQUES SIMILAR TO THOSE USED ELSEWHERE IN THE DEA, EXCEPT THAT COMPONENT LEADS ARE USED FOR SOLDER TERMINALS. THIS WORK INVOLVES "NON-STANDARD" TERMINATIONS PERFORMED DURING REWORK OF THE A9A1 BOARDS AND REQUIRE QUALIFICATION IN ACCORDANCE WITH THE GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION STANDARD PARTS MOUNTING DESIGN REQUIREMENTS FOR SOLDERED PRINTED WIRING BOARD ASSEMBLIES, MSFC 136, PARAGRAPH 5.5. SINCE THIS TESTING WILL NOT BE PERFORMED, EDCP 168, DETAILING THE NON-STANDARD TERMINATIONS AND REWORK, WAS REVIEWED AND APPROVED BY THE JOINT ROCKWELL/NASA SOLDER WAIVER BOARD. EXTRA PRECAUTIONS AS DEFINED IN EDCP 168 AND THE ASSOCIATED PLANNING WERE EXERCISED DURING REWORK OF ALL UNITS TO INSURE THAT NO PROBLEMS WERE CREATED BY THE REWORK.

DEPLOYED ASSEMBLY S/N 101 WAS SUBSEQUENTLY SUBJECTED TO APPROXIMATELY 307 HOURS EXPOSURE TO THE THERMAL VACUUM ENVIRONMENT DURING SYSTEM TESTING AFTER INCORPORATION OR THE "WHITE WIRE" FIX. NO PROBLEMS RESULTED RELATING TO THE NON-STANDARD TERMINATIONS.

(B) TEST:
ACCEPTANCE TESTING OF ALL UNITS INCLUDES EXAMINATION OF PRODUCT, AVT, ACCEPTANCE THERMAL VACUUM TEST (ATVT), LEAK AND FUNCTIONAL TEST. QUAL TEST INCLUDES POWER, EMC, LEAK, BONDING, THERMAL VACUUM, QAVT, QVT, LIFE, SHOCK, HUMIDITY, AND PERFORMANCE AT THE LRU LEVEL. AS A PART OF QUAL TESTING, A SYSTEM TEST WAS PERFORMED WITH THE DA EXPOSED TO A QUAL LEVEL THERMAL VACUUM ENVIRONMENT AND THE EA-1, EA-2, AND SPA COLD PLATE TEMPERATURES CYCLED AT QUAL LEVELS. CERTIFICATION DEVIATIONS ARE REQUIRED FOR THE FOLLOWING: NON-EXPLOSION PROOF GIMBAL MOTORS; HUMIDITY, SALT FOG, AND SAND AND DUST ENVIRONMENTS; AND NON-STANDARD TERMINATIONS (COMPONENT LEADS USED AS TERMINALS) FOR THE DEA TRANSMITTER A9A1 MODULE. INTEGRATED AND SUBSYSTEM VERIFICATION IS PERFORMED AT KSC. SYSTEM DESIGN VERIFICATION TESTS WERE PERFORMED BY THE HUGHES AIRCRAFT COMPANY AT THEIR FACILITY. NASA CONDUCTED INTEGRATED KU-BAND AND TDRSS VERIFICATION TESTS AT THE ESTL (JSC) AND SOFTWARE COMPATIBILITY TEST AT SAIL AND PASSIVE RADAR PERFORMANCE EVALUATION TEST AT WSMR.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 05-2R-5300- 03

THE DA FAILED TO PASS THE HUMIDITY TEST AND WAS NOT SUBJECTED TO THE SALT FOG, AND SAND & DUST TESTS. CERTIFICATION DEVIATION RATIONALE INCLUDES: -

1) THE HUMIDITY, SALT FOG, AND SAND & DUST TEST REQUIREMENTS, ARE MUCH MORE SEVERE THAN THE DA WILL BE SUBJECTED TO DURING TRANSPORTATION, INSTALLATION AND OPERATION, INCLUDING LAUNCH AND LANDING, BECAUSE OF ITS PROTECTED LOCATION IN THE PAYLOAD BAY.

2) PAINT PEELING/BLISTERING, AS OCCURRED DURING THE HUMIDITY TEST, CAN BE DETECTED BY NORMAL TURNAROUND INSPECTION IN TIME TO MAKE APPROPRIATE REPAIRS BEFORE ANY SIGNIFICANT DAMAGE CAN OCCUR.

3) WAVEGUIDE CORROSION, AND THE ATTENDANT "HANG-UPS" OF THE DMA WAVEGUIDE SWITCH AND THE POLARIZATION SWITCH, ARE NOT EXPECTED IN THE PAYLOAD BAY ENVIRONMENT. TURNAROUND TESTING WILL DETECT "HANG-UP" PROBLEMS SHOULD THEY OCCUR.

4) THE LOW POWER MONITOR READINGS DURING THE TEST WERE DUE TO MOISTURE IN THE WAVEGUIDE; THIS CONDITION WILL NEVER BE EXPERIENCED DURING TURNAROUND TESTING OR DURING ON-ORBIT OPERATIONS. THE FAILURE OF THE WIDE BEAM POWER MONITOR READING AFTER DRY-OUT WAS INDICATIVE OF EXCESSIVE LOSS IN THE WIDE BEAM ROTARY JOINT WHICH WAS DUE TO A DESIGN DEFICIENCY (LACK OF POWER HANDLING CAPABILITY) OF THE MDL RF ROTARY JOINTS. THE MDL ROTARY JOINTS HAVE BEEN REPLACED BY ITEMS MADE BY KEVLIN WHICH HAVE PASSED ALL QUALIFICATION TESTS INCLUDING HUMIDITY, SALT FOG AND SAND & DUST TESTS AT THE ROTARY JOINT LEVEL.

5) NO ENCODER MALFUNCTION WAS EXPERIENCED DURING THE HUMIDITY TEST BUT AN ANOMALY WAS EXPERIENCED DURING THE WSMR RADAR VERIFICATION TEST DUE TO DUST DEPOSITS ON THE OPTICAL DISK. THE PROBABILITY IS VERY LOW THAT SALT OR DUST DEPOSITS WILL OCCUR DURING ORBITER OPERATIONS DUE TO THE PROTECTED PAYLOAD BAY ENVIRONMENT OF THE DA. TURNAROUND TESTING WILL DETECT ENCODER PROBLEMS SHOULD THEY OCCUR.

6) THE SLIGHT MOTOR CORROSION OBSERVED AFTER THE DA HUMIDITY TEST DID NOT CAUSE A PERFORMANCE PROBLEM SO THE MUCH LESS SEVERE PAYLOAD BAY ENVIRONMENT IS NOT EXPECTED TO RESULT IN ANY PERFORMANCE PROBLEMS.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
RECEIVING INSPECTION VERIFIES INCOMING MATERIALS.

CONTAMINATION CONTROL
CONTAMINATION CONTROL PROCESSES ARE MONITORED BY QE. PRECAUTIONS ARE TAKEN TO PREVENT CONTAMINATION (SMOCKS, GLOVES, HATS, BOOTIES AS REQUIRED

ARE WORN, AND EATING & DRINKING ARE PROHIBITED). SIGNS ARE POSTED IDENTIFYING CLEANLINESS REQUIREMENTS IN WORK AREAS.

ASSEMBLY/INSTALLATION
INSPECTION WITNESSES CONTAMINATION CONTROL, SOLDERING, BONDING AND TORQUE OPERATIONS. QE ENSURES WORK TICKETS REFLECT DRAWING AND SPEC REQUIREMENTS. DETAILED INSPECTION IS PERFORMED ON ALL ASSEMBLY AND DETAIL PARTS PRIOR TO NEXT OPERATION PER PROGRAM QUALITY REQUIREMENT AND WORK TRANSFER QUALITY REQUIREMENTS. INSPECTION REQUIREMENTS ARE TRANSMITTED TO OUTSIDE VENDORS, AND COMPLIANCE IS VERIFIED BY SOURCE INSPECTION AND VENDOR SURVEILLANCE. A FORMAL CONNECTOR ASSEMBLY/HANDLING TRAINING COURSE FOR ALL TECHNICIANS AND INSPECTORS WAS IMPLEMENTED IN NOVEMBER, 1986.

CRITICAL PROCESSES
CRITICAL PROCESSES, SUCH AS, SOLDERING AND CRIMPING, ARE CERTIFIED. THE FORMAL CERTIFICATION OF ALL TECHNICIANS AND INSPECTORS FOR CRIMPING OPERATIONS WAS IMPLEMENTED IN NOVEMBER, 1986. ANNUAL VISION TESTS ARE GIVEN TO INSPECTORS. ALL CRITICAL PROCESSES ARE MONITORED AND VERIFIED BY QC PER PROGRAM QUALITY REQUIREMENT INSTRUCTIONS.

TESTING
INSPECTION VERIFIES ATT/AVT, LEAK AND INSULATION RESISTANCE/DIELECTRIC STRENGTH TESTS. GIMBAL AND DEA RECEIVE THERMAL AND VIBRATION TESTS BEFORE THEY ARE INTEGRATED INTO THE DA WHERE FORMAL ATT/AVT ARE PERFORMED. USE OF NON-SKID TEST PROBES TO MINIMIZE SLIPPAGE WAS IMPLEMENTED IN SEPTEMBER, 1986.

HANDLING/PACKAGING
ALL KITTING, ASSEMBLY, TEST, INSPECTION, TROUBLESHOOTING, AND REWORK OPERATIONS ON STATIC-SENSITIVE DEVICES ARE PERFORMED AT STATIC-SAFE WORK STATIONS AND IN ACCORDANCE WITH PROGRAM INSTRUCTION. HARDWARE ITEMS ARE PACKAGED, PROTECTED, AND INSPECTED PER ENGINEERING DRAWING REQUIREMENTS AND PROGRAM QUALITY REQUIREMENT INSTRUCTIONS.

(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITIES CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:
MOD (GROUND CREW) WILL COMMAND THE KU-BAND VIA STORED PROGRAMS COMMANDS (SPC) EXECUTED IN THE SYSTEM MANAGEMENT (SM) SOFTWARE TO CONFIGURE KU-BAND SYSTEM TO STANDBY MODE ANYTIME THE ANTENNA IS PREDICTED TO POINT WITHIN 5 DEGREES OF THE APDS PYROS. THIS PRECLUDES INADVERTENT RADIATION OF APDS PYROS HIGHER THAN 20 V/M RMS DUE TO FAILURE OF TRANSMITTER INHIBIT.

PRINT DATE: 08/09/00

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 05-2R-6300- 03

DURING AOS, MCC WILL MONITOR THE KU-BAND SYSTEM AUTOMATIC CUTOFF FUNCTION, WHICH PROTECTS ISS, PAYLOADS AND EVA CREWMEMBERS FROM RADIATION IN EXCESS OF 20 V/M. IN THE EVENT OF A FAILURE MCC WILL COMMAND THE SYSTEM TO STANDBY MODE. DURING LOS PERIODS, THE KU-BAND IS NOT ACTIVELY POINTING; THEREFORE UNLESS THE KU-BAND WAS LAST POINTING AT ANY ISS STRUCTURE, INCLUDING THE SOLAR PANELS AND APDS, OR IS PREDICTED TO POINT AT THESE STRUCTURES, NO ACTION WILL BE TAKEN TO PREVENT INADVERTENT RADIATION. IF THE KU-BAND WAS LAST POINTING AT ANY ISS STRUCTURE, INCLUDING THE SOLAR PANELS AND APDS, OR IS PREDICTED TO POINT AT THESE STRUCTURES, THE KU-BAND SYSTEM WILL BE KEPT IN STANDBY MODE DURING THE LOS PERIOD.

- APPROVALS -

S&RE ENGINEERING	: VAN D. NGUYEN	: Van Nguyen
ORBITER SYSTEM SAFETY ITM	: POLLY STENGER-NGUYEN	: Polly Stenger-Nguyen
DESIGN ENGINEERING	: HAROLD COLLINS	: for Rasik N. Patel
SUBSYSTEM MANAGER	: RASIK PATEL	: Rasik N. Patel
NASA MOD	: E. GRANT SIOSSER, JR	: E. Grant Siosser
USA SAM	:	: 8/16/2000
USA ORBITER	:	: Suzanne Poole 8/16